RESEARCH MEMORANDUM

EXPERIMENTAL INVESTIGATION OF AXIAL-FLOW COMPRESSOR INLET STAGE OPERATING AT TRANSONIC RELATIVE INLET MACH NUMBERS

II - BLADE-COORDINATE DATA

By George W. Lewis, Jr.

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Cleveland, Ohio

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON
June 6, 1952

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SUMMARY

Supplementary blade-design data including rotor- and stator-blade coordinates and mean-line angles at the leading and the trailing edges are presented for a transonic axial-flow compressor inlet stage.

INTRODUCTION

The over-all performance of a transonic axial-flow compressor inlet stage operating at rotor relative inlet Mach numbers up to 1.1 is reported in reference 1. In order to supplement the general description of the blade design contained in reference 1, specific blade-coordinate data for rotor and stator blades are presented.

BLADE-COORDINATE DATA

Rotor. - Although the rotor-blade profiles described in reference 1 were designed along conical surfaces in order to closely represent the true streamline flow, it was desirable for fabrication purposes to express the blade profiles in rectangular coordinates in planes perpendicular to the stacking radius. Rectangular blade coordinates at four reference locations were obtained from the design conical coordinates by means of graphical fairing. A sketch of the rotor-blade layout and hub-contour coordinates is shown in figure 1. Rotor-blade design coordinates at four reference locations are given in figure 2. Leading- and trailing-edge radii varied from 0.015 to 0.020 inch.

Inspection of the fabricated blade-profile shapes with an optical comparator revealed good agreement with the submitted blade-coordinate data. Measured ratios of maximum blade thickness to chord length were 0.048 at the tip and 0.075 at the hub. Blade leading- and trailing-edge

mean-line angles as obtained from comparator layouts are presented in figure 3. The rotor-blade mean-line angles were determined along approximate streamlines from blade inlet to outlet based on the assumption of equal radial-streamline spacing. The measured rotor-blade-inlet angles of figure 3 are approximately 2° higher than the values given in figure 8(b) of reference 1, which were desired design values. The small discrepancy is attributed to the inaccuracies of the transformation process from conical to rectangular coordinates. The true rotor-incidence angles are, therefore, correspondingly smaller than the values given in reference 1.

The coordinates of a profile at the hub in a plane parallel to the blade base (section G-G) as measured with an optical comparator are given in figure 4 to indicate the form of the blade profile along the hub streamline.

Radial clearance between the rotor-blade tip and the outer casing varied from 0.023 to 0.026 inch and the axial clearance between the rotor and the stator at the hub was 1.75 inches.

Stator. - The stator blades were constructed by linear fairing between two circular-arc sections at the hub and the tip. A sketch of the subsonic stator blade is shown in figure 5 and rectangular coordinates for the hub and the tip sections are given in figure 6. The inner casing had a constant radius across the stator (5.186 in.) and a radial clearance of approximately 0.020 inch. Measured stator-blade mean-line angles at the leading and the trailing edges are given in figure 7. Measured stator maximum thickness ratios were 0.065 at the hub and 0.084 at the tip. Leading- and trailing-edge radii varied from 0.015 to 0.020 inch.

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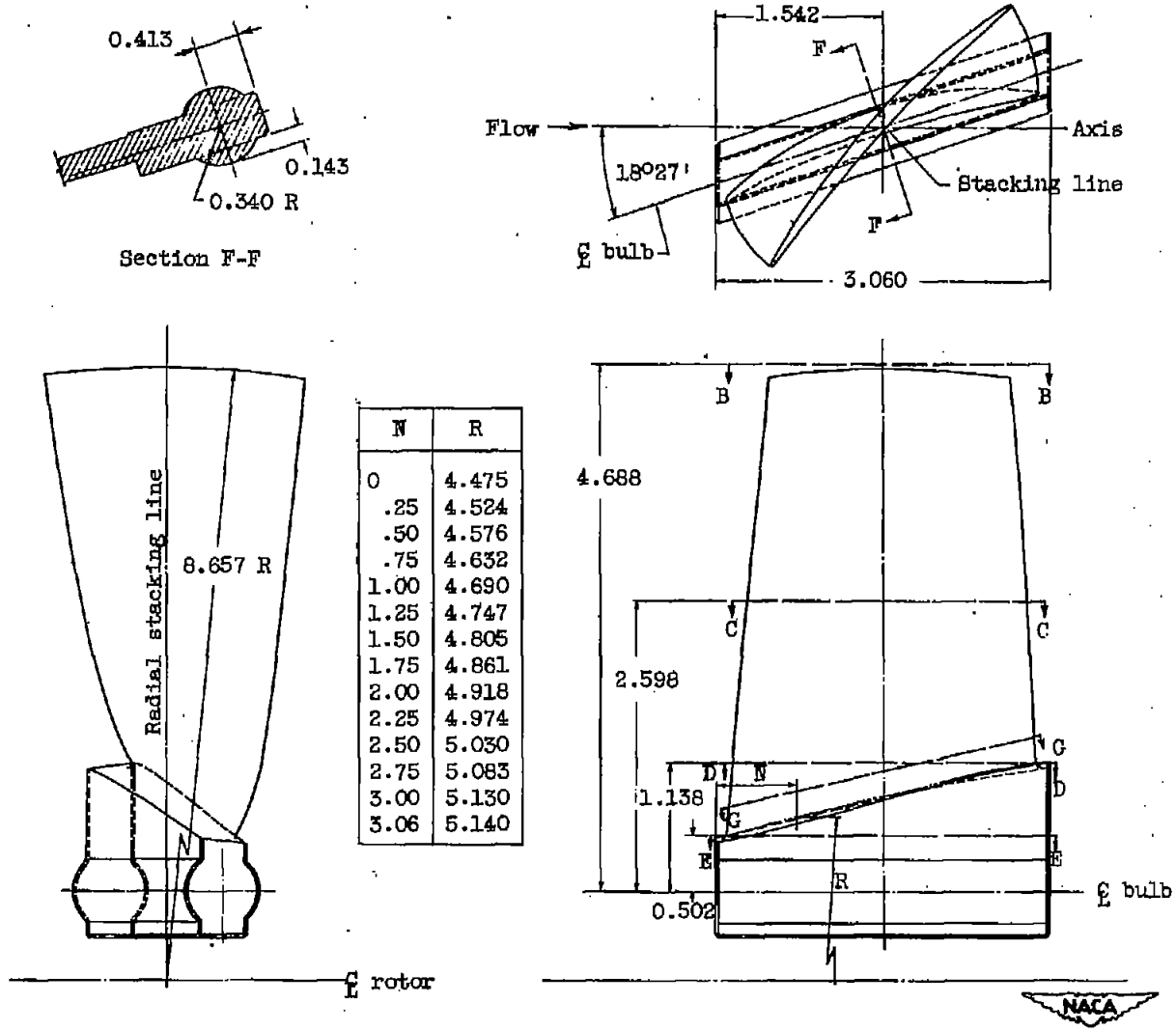
REFERENCE

1. Lieblein, Seymour, Lewis, George W., Jr., and Sandercock, Donald M.: Experimental Investigation of an Axial-Flow Compressor Inlet Stage Operating at Transonic Relative Inlet Mach Numbers. Part I - Over-All Performance of Stage with Transonic Rotor and Subsonic Stators up to Rotor Relative Mach Number of 1.1. NACA RM E52A24, 1952.



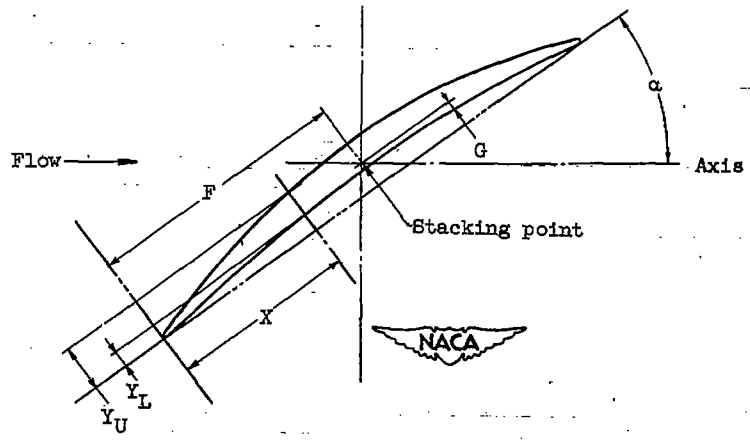
N	R
0	4.475
.25	4.524
.50	4.576
.75	4.632
1.00	4.690
1.25	4.747
1.50	4.805
1.75	4.861
2.00	4.918
2.25	4.974
2.50	5.030
2.75	5.083
3.00	5.130
3.06	5.140

Figure 1. - Rotor blade layout and hub-contour coordinates. Radius at bulb ℄ and radial stacking line, 3.992 inches. (All dimensions in inches except where noted.)

Section B-B

F = 1.612
G = .120
α = 47° 0'

X	Y_U	Y_L
0	0.015	0.015
.015	.031	0
.250	.080	.018
.500	.126	.037
.750	.165	.054
1.000	.196	.068
1.250	.217	.079
1.500	.228	.086
1.750	.229	.088
2.000	.219	.085
2.250	.199	.077
2.500	.169	.064
2.750	.128	.045
3.000	.077	.021
3.201	.030	0
3.216	.015	.015



Section C-C

F = 1.621
G = .172
α = 36° 0'

X	Y_U	Y_L
0	0.015	0.015
.015	.031	0
.200	.083	.025
.400	.135	.049
.600	.183	.071
.800	.224	.089
1.000	.258	.104
1.200	.285	.115
1.400	.304	.123
1.600	.314	.127
1.800	.314	.126
2.000	.303	.121
2.200	.282	.111
2.400	.250	.097
2.600	.207	.078
2.800	.153	.054
3.000	.085	.023
3.127	.032	0
3.142	.015	.015

Section D-D

F = 1.596
G = .272
α = 23° 15'

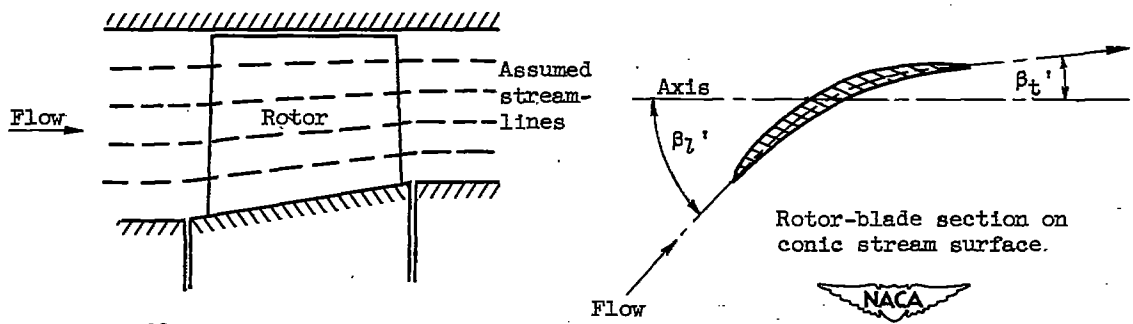
X	Y_U	Y_L
0	0.015	0.015
.015	.033	0
.200	.141	.058
.400	.228	.109
.600	.298	.151
.800	.352	.183
1.000	.393	.207
1.200	.422	.222
1.400	.439	.229
1.600	.445	.228
1.800	.440	.220
2.000	.421	.203
2.200	.387	.179
2.400	.336	.145
2.600	.264	.103
2.800	.168	.053
2.993	.033	0
3.007	.015	.015

Section E-E

F = 1.562
G = .081
α = 23° 15'

X	Y_U	Y_L
0	0.061	0.061
.015	.077	.046
.200	.160	.078
.400	.223	.103
.600	.268	.119
.800	.296	.123
1.000	.309	.116
1.200	.308	.098
1.400	.293	.067
1.600	.264	.025
1.800	.220	-.030
2.000	.159	-.096
2.200	.072	-.173
2.400	-.050	-.256
2.600	-.200	-.344
2.800	-.371	-.435
2.867	-.432	-.466
2.882	-.455	-.455

Figure 2. - Coordinates for rotor-blade sections of figure 1. (All dimensions in inches except where noted.)



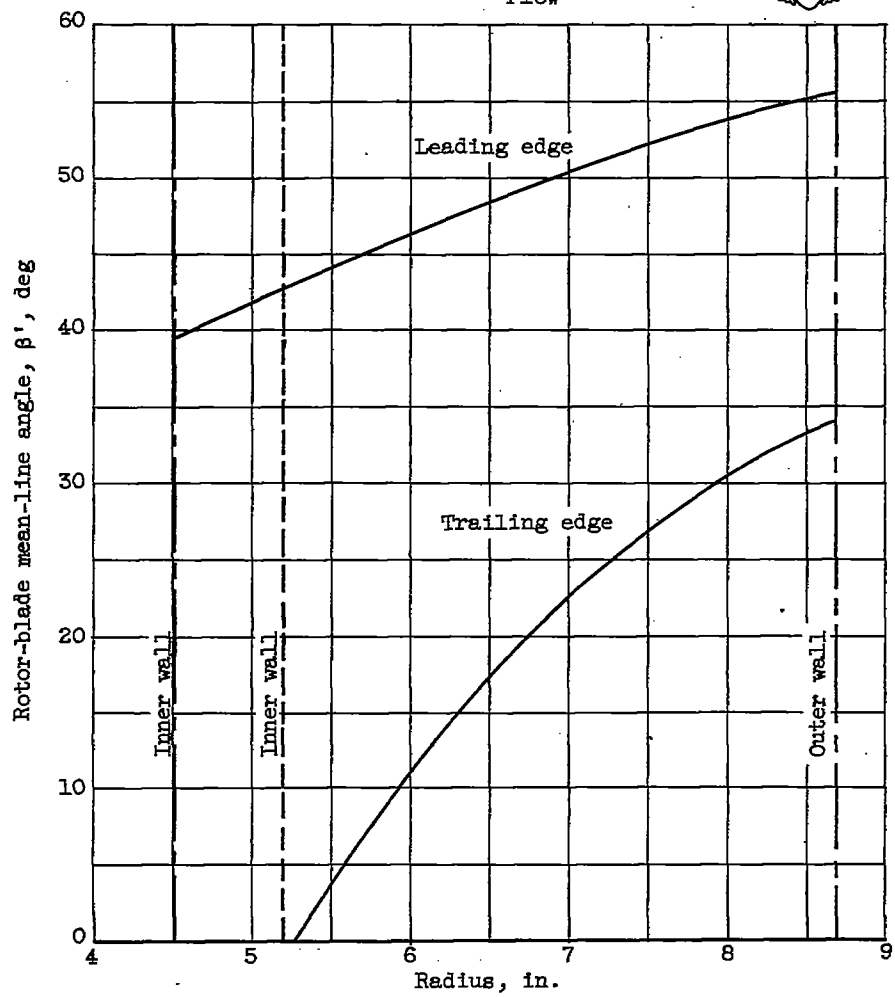
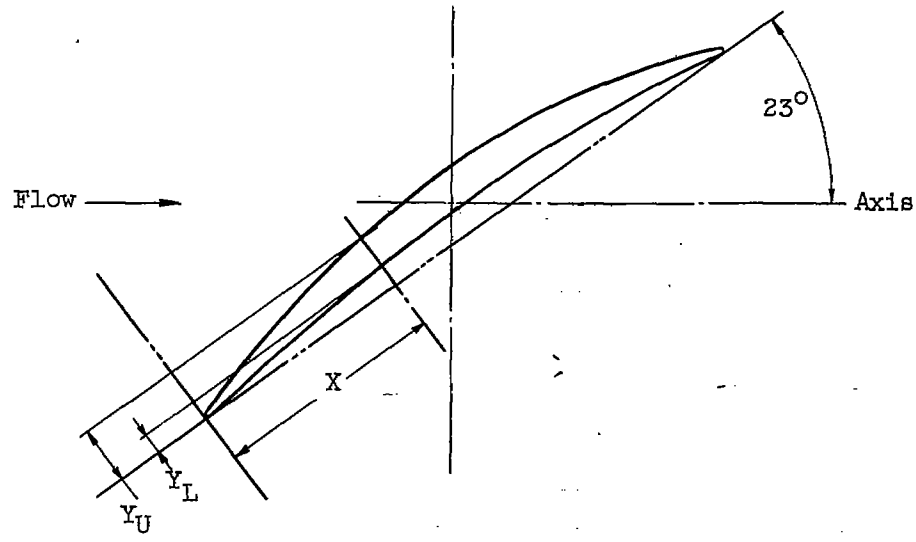


Figure 3. - Rotor-blade mean-line angles.



Section G-G

X	Y_U	Y_L
0	0	0
.025	.020	-.026
.200	.102	-.002
.400	.170	.031
.600	.221	.056
.800	.260	.072
1.000	.290	.083
1.200	.313	.090
1.400	.325	.096
1.600	.328	.098
1.800	.324	.095
2.000	.312	.087
2.200	.288	.072
2.400	.257	.057
2.600	.213	.035
2.800	.148	.009
3.000	.048	-.017
3.025	.034	-.019
3.050	.017	-.024
3.085	-.017	-.017

Figure 4. - Coordinates for measured profile at hub parallel to blade base obtained with optical comparator. Radius at leading edge is 4.824 inches and radius at trailing edge edge is 5.394 inches. (All dimensions in inches.)

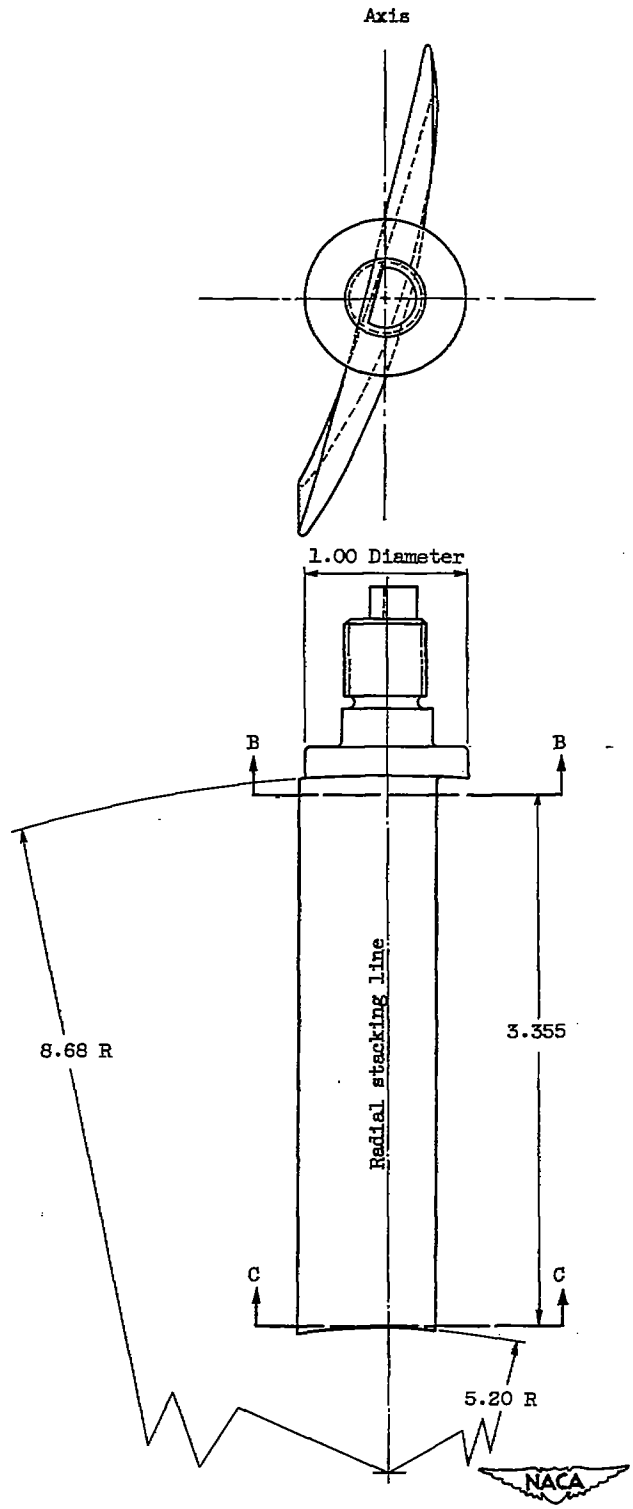
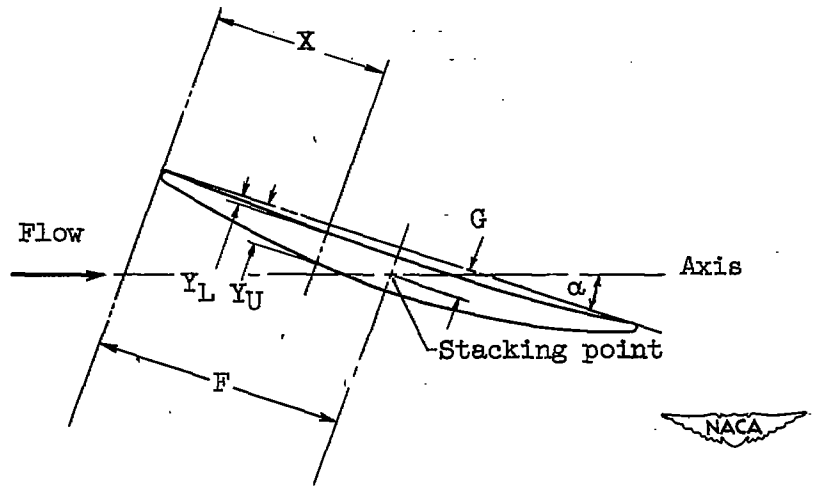


Figure 5. - Subsonic stator blade. (All dimensions in inches.)



Section B-B

F = 1.605 G = .150 α = 28.2°		
X	Y_U	Y_L
0	0.015	0.015
.100	.058	.002
.350	.129	.005
.600	.185	.009
.850	.227	.011
1.100	.259	.013
1.350	.278	.014
1.600	.286	.016
1.850	.278	.014
2.100	.261	.014
2.350	.230	.011
2.600	.187	.009
2.850	.132	.006
3.100	.062	.002
3.210	.015	.015

Section C-C

F = 1.315 G = .148 α = 33.7°		
X	Y_U	Y_L
0	0.015	0.015
.100	.057	.007
.350	.123	.028
.600	.173	.043
.850	.208	.054
1.100	.230	.062
1.350	.233	.064
1.600	.224	.060
1.850	.200	.053
2.100	.160	.040
2.350	.107	.024
2.600	.038	.002
2.630	.015	.015

Figure 6. - Coordinates for stator-blade sections of figure 5. (All dimensions in inches except where noted.)

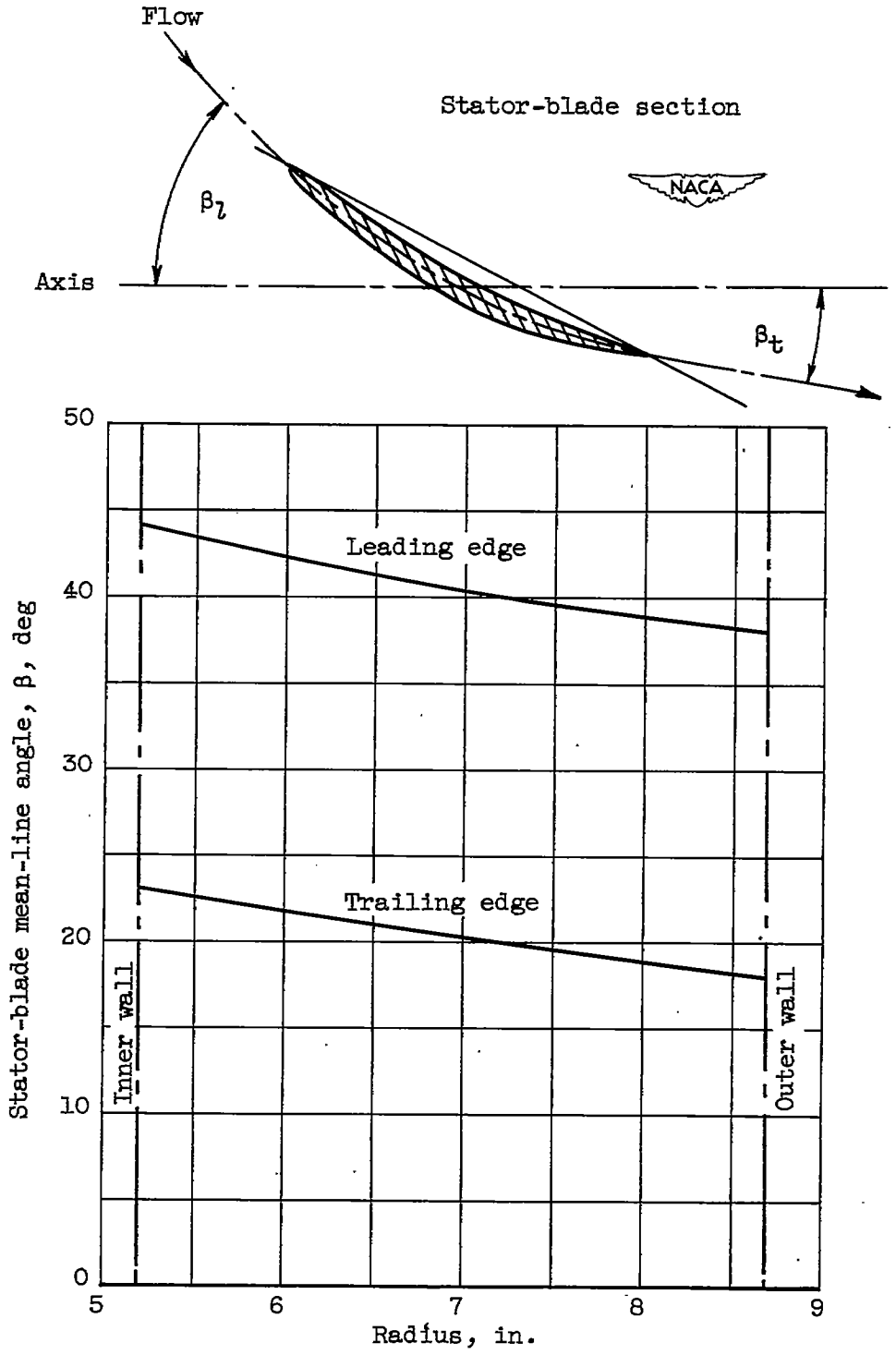


Figure 7. - Stator-blade mean-line angles.

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